

## DEVELOPING 5D SYSTEM CONNECTING COST, SCHEDULE AND 3D MODEL

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**ABSTRACT:** A recent topic, BIM could be considered as an effort to integrate all the information. So far, the integration of cost and schedule data has been done successfully as there is a good case of EVMS in order to synthesize those data. There have been many efforts to develop a 5D system that integrates cost, schedule data and a 3D model, but its technology is so difficult that few have succeeded. The 5D system will have many advantages once it is made: The visualization of schedule data and verification of cost in real time are possible and the future cost and schedule can be expected accurately. Especially, in case of an atypical structure the clash of members and errors of drawings which are hard to find in 2D drawings can be detected and corrected in a 3D model. This paper presents the methodology and results to develop a 5D system with the integrated cost and schedule data from EVMS, and a 3D model of the 2<sup>nd</sup> Geumgang Bridge within nD-CCIR, a 5D system developed in the UK.

**KEYWORDS:** BIM (Building Information Modeling), 5D System, EVMS (Earned Value Management System), Cable-Stayed Bridge, 3D Modeling, WBS, CBS

### 1. INTRODUCTION

BIM (Building Information Modeling) which many people say nowadays is linking 3D modeling with construction information such as schedule, cost data and etc, and it is managing various information through 3D modeling conventionally rather than new concept.

In short, BIM is the integration of information. Comparing the other industries, the construction industry has had many difficulties in being computerized, because its size is bigger than others and it has many uncertainties. It might be impossible before, but it becomes possible by drastically developed computer technology.

There has been a big stride in integration of information in many construction companies because they recognized its utility. EVMS (Earned Value Management System: cost and schedule management system in the firm), which Daelim Industrial Co., Ltd. (domestic construction company in Korea) developed as a tool of managing schedule and cost, enables us to know real-time schedule according to cost data and real-time cost according to schedule data by managing schedule and cost simultaneously. It is not conventional system managed with cost, but new system managed with cost and schedule. It is, however, difficult to understand the detailed schedule although it is well-explained, and moreover it takes much time for even workers concerned to know it, because it presents by only texts and tables. It has become necessary combining schedule, cost and 3D modeling so that anyone knows it

easily with visual effect.

There is very few 5D simulation software such as Virtual Construction made by Vico Software in Finland because of difficulty in making program and the domestic structure of cost is different from foreign one, which makes us not be able to use it. Although commercialized foreign estimating system based on BIM is more efficient and accurate than domestic one based on 2D, it takes much time in order to calculate more exact quantities and make more exact 3D modeling, because our domestic bidding system needs exact quantities other than rough one, which makes the limit on utilizing it. Furthermore, currently, management is much more concerned about contract and cost rather than production at construction work face (SRIPRASERT E. and DAWOOD N.).

Therefore it was recognized the necessity of developing new system endowed with already existing EVMS and 3D modeling and the scheme was presented. For experimental study on integrated system prior to developing web-based system, stand-alone system has been made and 2nd Geumgang Bridge which is cable-stayed bridge was selected as target structure because it has asymmetric and round pylon.

## 2. 2<sup>ND</sup> GEUMGANG BRIDGE

The 2<sup>nd</sup> Geumgang Bridge is being under construction now, the construction period of which is from 2008 to 2011 and located at the multifunctional administrative city, i.e., Sejong city in the middle of South Korea. A total length is 880m and it has 6 lanes of both bound. It is composed of cable-stayed bridge section (main span 200m and side span 140m) with composite steel plate girder, the stiffening girder of which is I shaped edge steel girder with precast concrete deck, and the pylon of which is round, asymmetric and 100m high, and approaching section (540m) with composite narrow steel box girder as shown in Fig. 1.

### 2.1 Overview

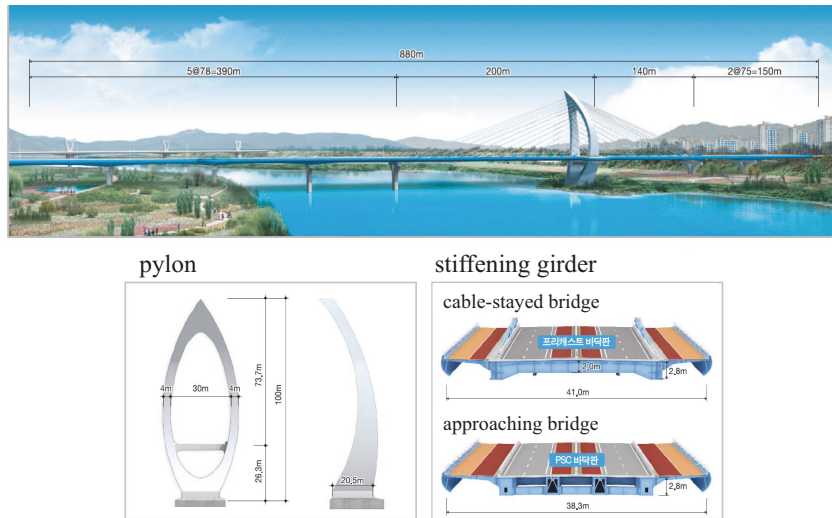


Fig. 1: Overview of 2nd Geumgang Bridge

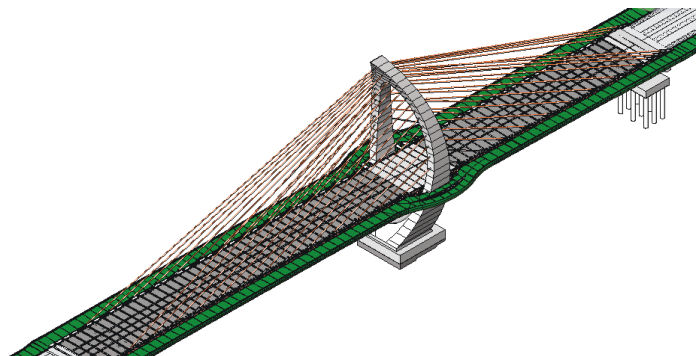


Fig. 2: 3D Modeling of 2nd Geumgang Bridge with Revit Structure 2009

## 2.2 3D Modeling

In Korea, unfortunately making 2D drawings is still conventional, which makes designer draw repeatedly in order to make 3D modeling. Once it is established, we can utilize it in various ways such as clash detection, planning simulation, decision-making, coordination support and so on. It is strongly insisted that drawing in 3D is settled in the near future in Korea. Making 3D modeling, which had been divided suitable for sub-activity in advance, was done with Revit Structure 2009 as shown in Fig. 2.

3D modeller had lots of difficulties in working because each member in 2D drawing did not include longitudinal slope and some errors such as clash between members were fixed. 3D modeling, or Revit file was transformed into IFC file which is an international standard of 3D modeling including information.

## 3. DESIGN OF 5D SYSTEM

### 3.1 EVMS

EVMS is the way of analyzing performance and expecting final project cost and schedule by managing schedule and cost of project and utilizing a structure of standard classifying based on schedule managing system.

EVMS is composed of WBS (Work Breakdown Structure) and CBS (Cost Breakdown Structure), and WBS at the level of sub-activity is connected with CBS at the 5th level of cost item. The 3D modeling is connected with WBS at the level of sub-activity and CBS is connected automatically with WBS by matching table as shown in Fig. 3. Therefore 3D modeling should be divided as to be adequate for sub-activity and WBS, CBS and matching table were extracted for linking with new system.

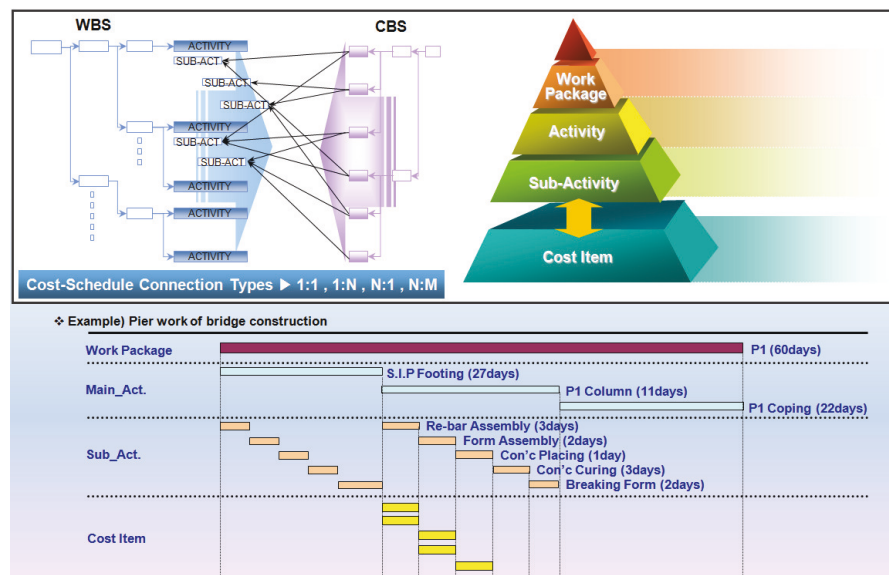


Fig. 3: Structure of EVMS

### 3.2 Customized nD-CCIR

The New system's name is so-called nD-CCIR which has been already developed by Prof. Nashwan Dawood and his team at Teesside University in Middlesbrough, UK and brief structure is as shown in Fig. 4 (BENGHI C. and DAWOOD N.).

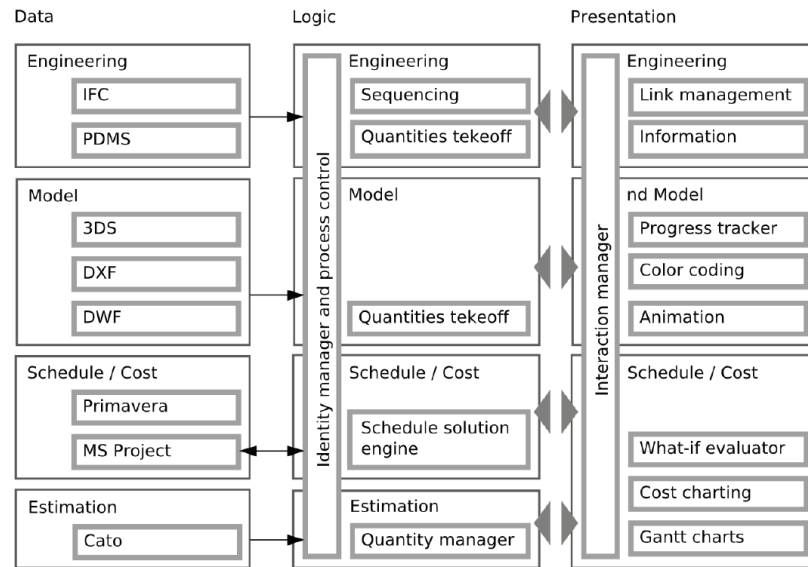


Fig. 4: Structure of nD-CCIR

Initially, because nD-CCIR took different input form and had nothing to do with EVMS, we felt the necessity of customizing it to our system environment including EVMS so that nD-CCIR, itself can download and manipulate EVMS data and 3D modeling. A program was developed with C# based on .NET framework and DirectX 9.0 was used as graphic engine. The data of cost and schedule in EVMS are downloaded once a month as form of XML which will be embedded ndp file, or nD-CCIR input file. Because data update is performed monthly, the data saved in local PC are shown before updating it. The 5D simulator embedded in program presents 3D modeling.

#### 4. RESULTS FROM 5D SYSTEM

After completing 5D system, we obtained the system as shown in Fig. 6. When the program is launched for the first time, linking 3D modeling with EVMS data will be done automatically, once 3D modeling is loaded. Typically, the system has 5 parts which are 3D modeling window, model list window, information window, Gantt chart window and cost inspector window. Each window can be easily moved by drag-and-drop of mouse.

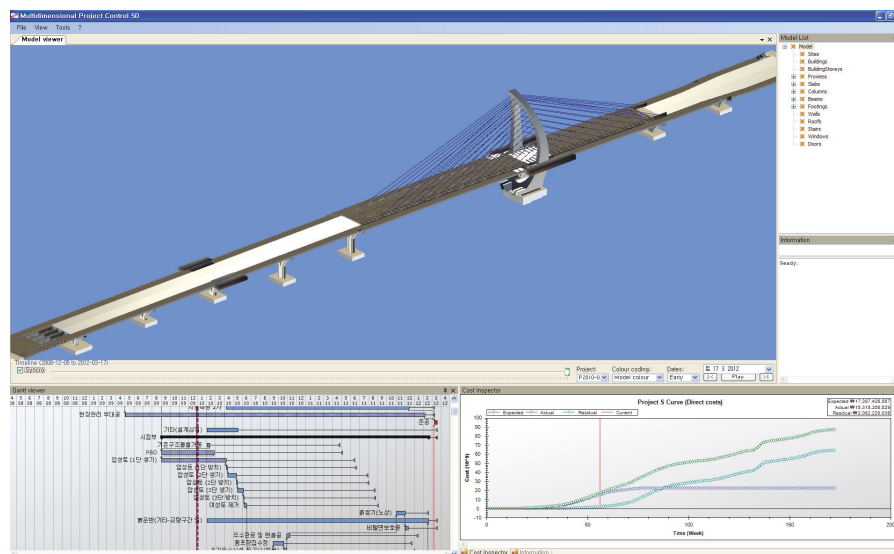


Fig. 6: nD-CCIR Endowed with EVMS Data

## 4.1 Managing Schedule and Cost with Visualization

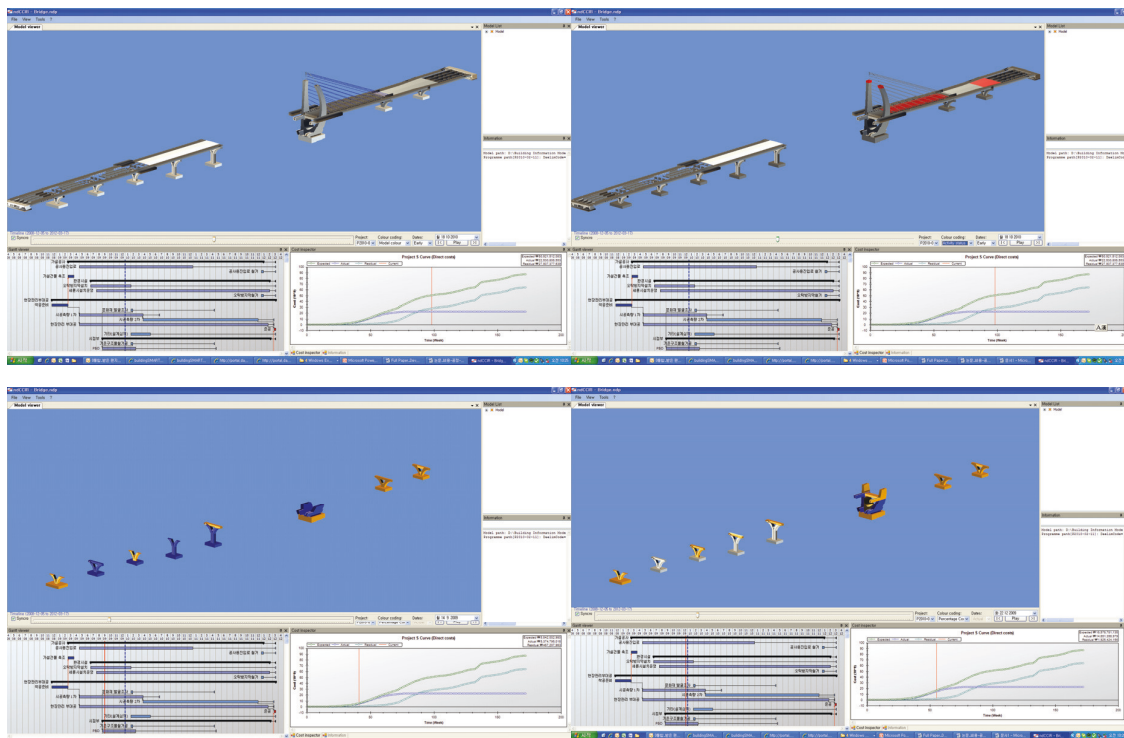


Fig. 7: Various Model Colours Representing Practical Status in Simulating Construction

The user is provided with various colours which can represent the practical status in simulating construction process as shown in Fig. 7. In model colour option, it is possible to simulate planned schedule with real colour. In activity status option, the colour of member related to running schedule turns red. In percentage control option, the member related to fast activity turns chrome if it finishes, the member related to delayed one turns red if it finishes, the member related to fast one turns blue if it is running, the member related to delayed one turns green if it is running, the member related to fast one turns bright orange if it does not start, and the member related to delayed one turns dark green if it does not start.

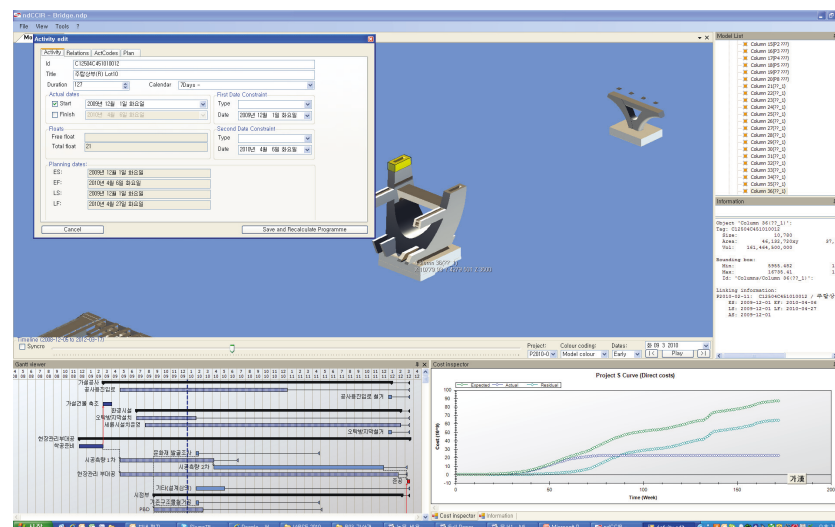


Fig. 8: Activity Edit Pop-Up Window



Also, the user can modify activity or relation about schedule in activity edit pop-up window, by selecting a specific member as shown in Fig. 8. It was very tiresome to modify an activity in Gantt chart because it is hard to search what they want to change, but by means of synchronized 3D modeling, it was totally solved.

The user can add another model viewer window up to 4, which allows them to compare different schedules. That makes it possible to save money or time by checking all possible procedures before constructing structure.

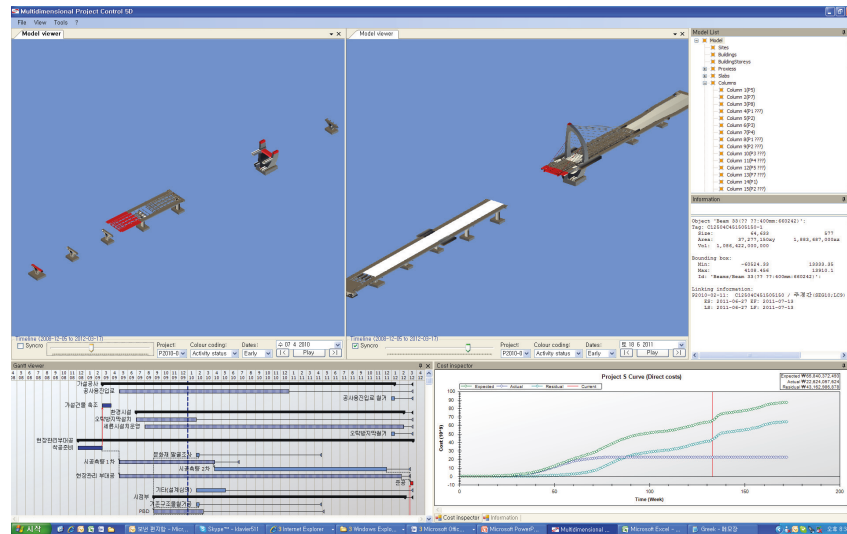


Fig. 9: Added 3D View for Comparing Different Schedules

## 4.2 Managing Information

The user can insert the information concerning specific member on product information window by right clicking it as shown in Fig. 10. The information can be all the valuable things such as manufacturer, material, strength and so on, that are the essential factor in BIM. The general properties such as dimension and schedule appear in information window, whenever the user selects a member. The categories of information can be expanded to anyone the user wants to include.

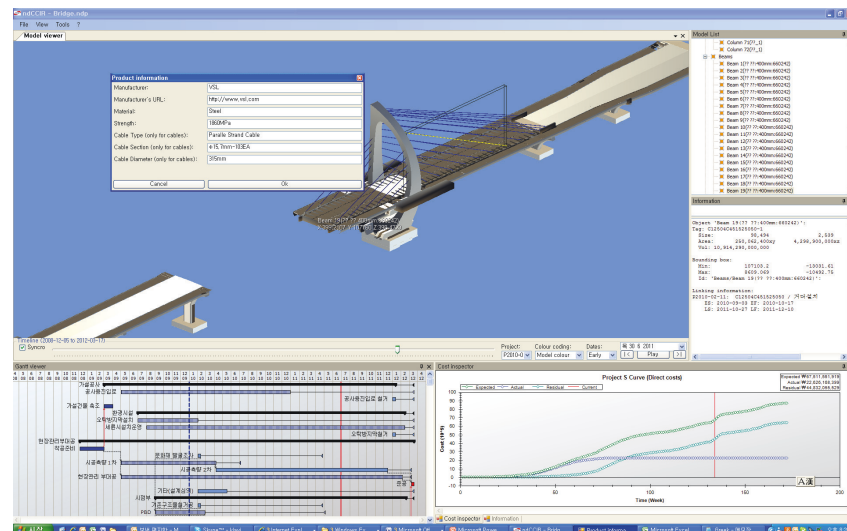


Fig. 10: Product Information Window and General Properties Information Window

Besides what were mentioned in this chapter, there are many beneficial aspects in nD-CCIR.

## **5. CONCLUSIONS**

This study has presented the methodology and result of developing 5D system, or nD-CCIR, which was previously made by professor Dawood and his team in Teesside University, UK and customized by themselves according to Daelim company's EVMS environment. It links schedule and cost which come from EVMS with 3D modeling of 2nd Geumgang Bridge, and shows various valuable results such as managing cost and schedule with visualization, and managing information about specific member.

Generally speaking, all the information can be saved, but the problem is that it has been difficult to utilize it. In addition, unfortunately, managing information properly has been neglected in the most cases of construction in spite of brilliant evolution of information technology. The point is how it is saved, retrieved and managed and it can be more beneficial only if it is managed with systematic and consistent way with BIM.

This study also tells us that BIM shows one of the possibilities that the mixture of construction and computer technology can be more useful to any concerned construction party such as client, engineer, contractor and etc. Because this system's type is stand-alone, user has to install the program on each computer, so it is difficult to check the status of project without installation. If web-based system were developed, it would be solved directly and we could know it anywhere. Therefore, web-based system will be developed in order to fix these problems, next year.

## **6. REFERENCE**

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